1 Introduction

Customization relates to the ability of firms to provide highly designed products that better suit to consumers' preferences. Product and pricing strategies for customized goods and services allow firms to gain a competitive advantage on rivals and may well explain why customization is becoming one of the most successful business strategies and a dominant model of production.

A customized product can be seen as a standard product modified according to customers' needs, like a car with some optionals or a composite product made of modules combined by the customer. The differences in customized products can be both physical differences and differences in services.[1] Software, music, books, as well as dresses and drinks are examples of industries of standard or information goods [2] whose characteristics are chosen by consumers on request, and that are sold both on digital marketplaces and by traditional retailers. This paper focuses on the role of strategic interaction among firms in a monopolistic competitive framework in explaining pricing strategies for customized goods and services and its impact on market structure. In particular, we examine customized production as a dimension of production flexibility and we investigate the patterns and the possible implications of firms' behaviour in the traditional and in the electronic markets. According to these purposes, the issues discussed in the paper are closely related to the economic literature on spatial product differentiation and spatial price discrimination, as well as to the literature on technological competition, on flexible production and electronic commerce.

Customization is the production of different versions of a basic good as a consequence of heterogeneity in tastes. Since these different versions are sold at different prices, the analysis of customization has often been associated to that of price personalization (or perfect price discrimination). It must be stressed that the literature has mainly focussed on the pricing problem (e.g. Ulph and Vulkan, 2000 and 2001), which has been generally explained in terms of consumers' willingness to pay. As an example, most of the econometrics software is provided in two different versions: the most complete, also most expensive, for professional users, and the simplest, also cheapest, for light users, tipically students. Indeed, sophisticated collecting-information systems on consumers' profiles make it possible nowadays to

[1] Customization in services may concern transportation, assistance, insurance and guarantees, etc.

[2] Following Shapiro and Varian (1999), I take as information good everything that can be digitalized: text, images, voice, data, audio and video.

highly discriminate and personalize prices. The focus of this paper is rather on the technological aspect - the ability of firms to redisgn easily and quickly their products in order to match consumers' desires - and price personalization comes as a result of 'technological' factors and strategic interaction.

As suggested above, product customization is particularly relevant in digital markets, where the availability of more flexible technologies makes customization feasible at reasonable low costs: information technologies, like technologies for processing, reproducing and distributing information, for example, enable firms to change design and offer quickly and inexpensively one standard item and different versions of a good: software packages, personally configured computers, music, books and video-games are for this reason considered suitable for customization. Product customization strategies, and the associated price discrimination practices, can be "more widely practiced in electronic commerce since the transmutability of digital products make them highly customizable and detailed data on consumer preferences are more abundant in a computerized market environment" (Choi et al, 1997, p.8-1). Indeed, in the digital markets consumer profiles are easily inferred by web-based transactions [3], which convey information on consumers' preferences. As real world examples one might quote Dell Computers and IBM, Motorola, Hewlett-Packard, which are increasingly customizing their products [4]. Interesting cases of customization are more often found in the e-commerce: McGraw Hill publisher, for example, makes now possible to order a book designed according to the preferred configuration: different chapters of the books are combined by customers and printed or produced in a media format (CD-ROMs, DVDs or downloadable files from the Internet) on consumer demand.

The decision of a firm to customize a product is a strategic decision (Wallace, 2004). To customize a product imposes a cost which depends on technological factors, but it allows the firm to capture a larger share of consumers - this gain in terms of demand depending on the price paid for receiving a customized product. This price must reflect the additional burden borne by the firm. In order to capture this aspects, the most appropriate general framework is a traditional spatial model in that a customized product can be considered as a finely differentiated product (Choi et al., 1997). Moreover, in this kind of set-up, the cost of customization can be assimilated to a transportation cost paid by firms. A famous example of spatial model

[3] Firms often use the web to collect personal information through cookies, newsletters, registrations and subscriptions.

[4] For further examples see Vulkan (2003), pp. 47-48

in which transportation costs are paid by firms and then translated to consumers is the Thisse and Vives's (1988) discriminatory pricing model [5] which perfectly replicates Hotelling's analogy between spatial location and preferences: different prices charged at each location (different delivery prices) can be seen as different prices charged for different versions of a basic product. Using the example offered by Thisse and Vives on cider, the attributes of the latter, e.g. its different levels of sweetness, correspond to the varieties that are priced differently, and the price paid for each variety depends on the 'transport' cost of altering the basic product. The role of transportation costs is not discussed in that paper, however they are clearly interpreted as the technological cost of redesigning the basic product - as Thisse and Vives state "How to change the sweetness of cider is a technical detail that we leave to the imagination of the reader" (p. 125). This is the point this paper deals with in an economic perspective. If different customization technologies are available, if firms may choose their 'customization' cost, which is their optimal choice and its final implications in terms of market structure and equilibrium prices?

While this issue has not been previously analysed in the product customization literature, the problem of endogeneizing transportation costs has already been studied in a different perspective. Von Ungern-Sternberg (1988) and Hendel and Figueiredo (1997) present respectively a simultaneous and a sequential game where firms engage in a product design competition modelled as a transportation cost competition, prior to price competition. In these Hotelling-type models, uniform pricing policy and perfectly inelastic market demand are assumed. The extent of transportation cost captures the so-called general purposeness of products. In the first model simultaneity leads firms to choose optimally the lowest level of the transportation cost: a generalist good is therefore produced and this results in a tougher price competition. In the second, the strategic effect on pricing due to the sequential structure of the game induces firms competing in a duopoly setting to set a higher level of the transportation cost (they offer a more 'specific purpose' good or, in other words, they increase the degree of focus of their products), softening price competition. The results in both models rely on the assumption of costless ability of firms to change focus. However, the existence of a cost of producing a general purpose product creates an additional incentive for firms to increase focus in order to save costs.

While in these contributions firms' competition in transportation costs

[5] For a review on the issue of price discrimination in imperfectly competitive markets, see Stole (2003). See also Armstrong and Vickers (2001).

is interpreted as a design competition leading firms to make their products more specific or more general with respect to consumers' preferences, in this paper the transportation cost competition is assimilated to a technological competition. Changes in transportation costs are seen as technological changes associated to the customization process. Therefore, the pricing strategies for customized products result from competition in the technology of customization and from competition in final prices. The main result of the paper is that this technological competition intensifies price competition (consistently with the findings in the literature on innovation), leading to a market configuration characterized by high concentration and low prices for each variety of the customized good. In a sense the model may be seen as an attempt to justify the observed phenomenon of mass-customization: a few basic varieties of products are offered, but in many versions and at low prices.

The paper is organized as follows. In section 2 the spatial framework adopted in the model is briefly described. Section 3 analyses a three stage-game in which, after profitable entry, firms engage a technological competition on customization costs and prices. This game is studied under two alternative hypotheses on the choice of customization costs: in section 3.1 this is assumed to be costless, i.e. firms may choose different customization technologies without altering the production cost of the basic variety; in section 3.2 this simplified assumption is relaxed, by positing that more efficiency in customization requires higher set-up costs. In the same section a brief discussion of the mass-customization phenomenon is also offered. Finally, some concluding remarks and comments are gathered in section 4.

2 The spatial framework

Competitive product differentiation under discriminatory pricing allows to study product customization. As mentioned above, the standard spatial model of price discrimination drawn from Thisse and Vives (1988) is used on this purpose. In order to investigate the long run equilibrium generating by a free-entry process, this framework is combined with the Salop model (1979).

More specifically, I consider the market for a horizontally differentiated product, whose characteristics may be represented as points of a circle. Consumers are heterogeneous in preferences and uniformly distributed on this circle whose length is normalized to 1. Firms are located symmetrically on this characteristics space. In what follows a unit demand is assumed at all